LATE MIDDLE CAMBRIAN AGNOSTID TRILOBITES FROM NORTH-WESTERN TASMANIA

by J. B. JAGO

ABSTRACT. Eighteen species of agnostid trilobites are described from three late middle Cambrian faunas from the St. Valentines Peak and Christmas Hills areas in north-western Tasmania. Two new genera, *Tasagnostus*, type species, *T. debori* sp. nov. and *Valenagnostus*, type species, *V. marginatus* (Brögger) are erected. The following new species are described, *Peronopsis gullini*, *P. ekip*, *Valenagnostus banksi*, *V. brittoni*, *Ptychagnostus* (*Goniagnostus*) *buckleyi*, *Utagnostus neglectus*, *Tasagnostus debori*, and *T. compani*. Some of the effaced agnostids are reviewed. It is concluded that the new genus *Valenagnostus* includes the following species, *V. marginatus* (Brögger), *V. imitans* (Öpik), *V. evexus* (Öpik), *V. banksi*, and *V. brittoni*. The effaced agnostids usually described under *Grandagnostus*, *Phalacroma*, or *Phalagnostus* should be split into at least three genera, namely, *Valenagnostus*, *Grandagnostus* Howell with *G. glandiformis* (Angelin) as the best-known species, and *Phalagnostus* Howell which includes *P. nudus* (Beyrich) as type species, *P. prantli* Šnajdr, and *P. scanicus* (Tullberg).

THE purpose of this paper is to describe all previously undescribed agnostid trilobites from the Christmas Hills (lat. 40° 54·1′ S., long. 144° 29·8′ E.) and St. Valentines Peak (lat. 41° 21·6′ S., long. 145° 44·3′ E.) areas in north-western Tasmania. These localities contain some of the best-preserved late middle Cambrian fossils in Tasmania. There are three faunas involved—two from Christmas Hills and one from St. Valentines Peak. Prior to this paper only five trilobite species had been described from these localities (Jago 1972; Jago and Daily 1974). Some palaeoecological aspects of the three faunas were discussed by Jago (1973).

Jago and Buckley (1971) reported the abrupt faunal change between the older and younger faunas at Christmas Hills, despite the very similar ages of the faunas. In the lower fauna *Proampyx* and *Nepea* are common. Other polymerids include an asaphiscid and very rare examples of *Dorypyge*. The agnostid trilobites described herein from the lower fauna are *Peronopsis gullini*, *Valenagnostus brittoni*, *Tasagnostus debori*, and *Utagnostus neglectus*. *Clavagnostus milli* has been described previously (Jago and Daily 1974). Of these species *T. debori* (referred to in previous papers, e.g. Jago 1973, as cf. *Oidalagnostus*) occurs in great abundance. *P. gullini* and *V. brittoni* are fairly common, but *C. milli* is scarce and *U. neglectus* is known only from a single specimen. At least two species of inarticulate brachiopods and very rare dendroids are also known from the lower fauna, which is probably of *Lejopyge laevigata* I age (Jago and Buckley 1971).

The polymerid trilobites from the upper fauna at Christmas Hills include *Centropleura*, *Pianaspis*, *Amphoton*, and others; the agnostids include *Peronopsis gullini*, *Hypagnostus* cf. *brevifrons* (Angelin), *Grandagnostus* sp., *Ptychagnostus* (*Ptychagnostus*) cf. *aculeatus* (Angelin), *P.* (*Goniagnostus*) *buckleyi*, *Diplagnostus* sp., *T. debori* and Agnostid, gen. et sp. indet., no. 3. *Clavagnostus* sp. was described in Jago and Daily (1974). The most common agnostid in the upper fauna is the effaced agnostid

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described here as Agnostid, gen. et sp. indet. no. 3; *P. buckleyi*, *Grandagnostus* sp., and *Diplagnostus* sp. are common. Dendroids and hydroids (Quilty 1971), inarticulate brachiopods, hyolithids, and sponge spicules are also known from the upper fauna at Christmas Hills which is either of *L. laevigata* I or *L. laevigata* II age (Jago and Buckley 1971; Jago 1973).

The Cambrian stratigraphy of the St. Valentines Peak area is described in Jago *et al.* (1975). Newly described agnostids from St. Valentines Peak are *Peronopsis ekip*, *V. banksi*, *Aspidagnostus* sp., *T. compani*, *Utagnostus*(?) sp., Agnostid gen. et sp. indet. no. 1 and no. 2. *C.*(?) *rawlingi* has been described (Jago and Daily 1974). Other trilobites include *Opsidiscus argusi* Jago, *Schmalenseeia gostinensis* Jago, *Nepea*, and a zacanthoid. The age of this fauna is late middle Cambrian, probably either *L. laevigata* III or *Damesella torosa–Ascionepea janitrix* Zone (Jago 1972). The latter zone was erected by Öpik (1967) as a passage zone between the middle and upper Cambrian, but it has recently been shown to be of late middle Cambrian age (Daily and Jago 1975).

All Tasmanian Cambrian fossils have undergone tectonic distortion to some extent. As noted by Henningsmoen (1960, p. 207), there are three main types of symmetrical distortion with respect to the orientation of bilaterally symmetrical fossils such as trilobites: (*a*) a dorso-ventral compression (flattening), (*b*) sagittal elongation (the L form of Henningsmoen) (e.g. Pl. 21, fig. 1), and (*c*) transverse elongation (the W form) (e.g. Pl. 23, fig. 9). Those fossils in which the distortion has been asymmetrical are stated here to have undergone intermediate distortion (i.e. the compression took place at an oblique angle to the length of the trilobite, e.g. Pl. 23, fig. 13). In cases where no comment is made about the type of distortion, it is because the distortion is so slight as to make it difficult to determine the type.

All statements made in the descriptions, such as 'the cephalon is about as wide as is long', are made after taking the effect of distortion into account. Admittedly, this is a subjective assessment, but I feel that, after inspecting and studying several thousand distorted agnostid specimens, such a judgement seems reasonable. Unless otherwise stated, all length measurements were taken in a sagittal or exsagittal line, all width measurements were taken in a transverse direction.

It should be noted that the trilobites from the Christmas Hills and St. Valentines Peak area are among the least distorted of Tasmanian Cambrian faunas. All trilobites from these localities are preserved as internal and external moulds in weathered siltstone. In order to prepare them for description, silicone rubber casts of the external moulds were prepared. These rubber casts were then photographed after being whitened with magnesium oxide. All specimens are housed in the collection of the Geology Department, University of Tasmania. The catalogue numbers refer to this collection.

HABITAT OF AGNOSTID TRILOBITES

Robison (1972*a*, 1972*b*) reviewed the various hypotheses regarding the mode of life of agnostid trilobites. He concluded that the distinctive agnostid morphology is the result of adaptation to a pelagic mode of life in the oceanic province. The author's work indicates general support for this view although in the Tasmanian Cambrian

sequences there is strong evidence that certain agnostid groups lived in a more open-sea type environment than others (Jago 1973). A possible explanation for this is that of Bergström (1973) who suggested that some agnostid species were pelagic while others may have been benthonic. On the other hand, the agnostids which occur in the closer-to-shore assemblages in Tasmania include species of *Peronopsis* and *Clavagnostus*. Species of these genera have a world-wide distribution.

Bergström (1973) postulated that agnostids may have been parasitic although, as he noted, there are certain agnostid characteristics which do not support such a hypothesis. In fact, such a hypothesis, although it cannot be disproved, seems unnecessary. I feel that it is much more likely that the agnostids drifted near the surface of the seas at the mercy of the currents. The diet of agnostids is still unknown.

Robison (1964, 1972*b*) noted various features of agnostid morphology which he regarded as indicating that agnostids spent most of their life enrolled. Most, if not all, of the agnostid characteristics used by Robison to suggest this mode of life seem to be simply adaptations for enrolment. Great numbers of polymerid trilobites are known to have enrolled, and it is not suggested that this was their usual way of life. Even allowing for the fact that agnostids differ in many ways from other trilobites, there is no reason why the enrolled position should be considered to be the normal mode of life of the agnostids.

In faunas with which I am familiar and in which complete agnostids are common, the unenrolled specimens by far outnumber the enrolled specimens. It is possible that in most faunas a large number of the unenrolled complete specimens could be due to moults. However, in faunas where it seems reasonable to assume that most specimens represent dead animals rather than moults there is still a very high ratio of unenrolled to enrolled specimens, e.g. the Que River fauna (Jago 1973) where only three out of twenty-six complete specimens are enrolled. Although it could be argued that some of the unenrolled specimens were enrolled when they died and that relaxation of muscles after death caused the agnostid to open out and settle to the bottom in the unenrolled state, the presence of a few enrolled specimens which have failed to open out argues against this. It is concluded that agnostids were unenrolled for the greater part of their existence. In considering the enrolled position of agnostids it is possible that the cephalo-thoracic aperture of Robison (1964) could be related to maintaining hydrostatic equilibrium when the agnostid went into the enrolled position.

Robison (1972*b*) suggested that an agnostid may have been able to swim by clapping the cephalon and pygidium together in a manner similar to a modern pectenid bivalve. Presumably, like the pectens, such swimming, if it occurred at all, would have been rather erratic and of short duration. Such swimming would probably have taken place in an attempt to escape predators or to search for food.

CLASSIFICATION AND MORPHOLOGY OF AGNOSTID TRILOBITES

Öpik (1961*b*, 1963, 1967) discussed the classification of agnostid trilobites, culminating in his detailed classification of 1967. This classification differs considerably from those of Kobayashi (1939, 1962), Hupé (1953), Howell (1959), and Pokrovskaya (1960). Bergström (1973) accepted Öpik's classification with very little modification.

Öpik's classification is accepted here as being more objective and consistent than previous classifications.

The morphology and terminology of agnostids has been discussed by Palmer (1955), Öpik (1961*a*, 1963, 1967), and Robison (1964); that of Öpik is the most complete and is usually followed herein.

SYSTEMATIC DESCRIPTIONS

Order MIOMERA Jaekel, 1909
Suborder AGNOSTINA Salter, 1864
Superfamily AGNOSTACEA M'Coy, 1849
Family AGNOSTIDAE M'Coy, 1849
Subfamily QUADRAGNOSTINAE Howell, 1935
Genus PERONOPSIS Hawle and Corda, 1847

Synonymy. See Palmer 1968, p. 31.

Type species. Battus integer Beyrich, 1845, p. 44, pl. 1, fig. 19.

Diagnosis. See Robison 1964, p. 530 and discussion on *Peronopsis ekip* sp. nov. (below).

Peronopsis gullini sp. nov.

Plate 21, figs. 1–9

Material. One large almost complete specimen, UT 86599, the holotype, and two smaller complete specimens are known. Numerous pygidia are available. It is impossible to differentiate cephala of *P. gullini* sp. nov. from those of *Tasagnostus debori* sp. nov. with certainty. However, the latter is a larger agnostid than *P. gullini*, and thus all the large cephala of this type in the lower fauna at Christmas Hills are included in *T. debori.*

Holotype. UT 86599 (Pl. 21, fig. 1).

Diagnosis. Simple basal lobes moderately large; transverse glabellar furrow arched to the posterior. Cephalic margins converge forward to a well-rounded cephalic front; pygidial margins diverge slightly to the short border spines. Posterior pygidial

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EXPLANATION OF PLATE 21

Figs. 1–9. *Peronopsis gullini* sp. nov. 1–8, from lower fauna and 9 from upper fauna at Christmas Hills (lat. 40° 54·1′ S., long. 144° 29·8′ E.). 1, UT 86599, holotype, nearly complete specimen, L form, ×7·8. 2, UT 86849b, internal mould of small complete specimen, L form, ×13·2. 3, UT 86849b, internal mould of small complete specimen, intermediate distortion, ×13·1. 4, UT 86855e, pygidium, intermediate distortion, ×12·5. 5, UT 86861b, pygidium, intermediate distortion, ×11·5. 6, UT 86853d, pygidium, W form, ×11·2. 7, UT 86853f, pygidium, L form, ×11·1. 8, UT 86845c, pygidium, intermediate distortion, ×11·3. 9, UT 92468, pygidium, W form, ×9.

Figs. 10–16. *Peronopsis ekip* sp. nov. near St. Valentines Peak, lat. 41° 21·6′ S., long. 145° 44·3′ E. 10, UT 92692, cephalon, ×13. 11, UT 92712, pygidium, ×15·2. 12, UT 92010 cephalon, ×18·2. 13, UT 92714, cephalon, ×17·9. 14, UT 92715, pygidium, ×13·1. 15, UT 92687, holotype pygidium, ×26. 16, UT 92689, pygidium, ×6·4.

Figs. 17–18. *Hypagnostus* cf. *brevifrons* (Angelin). Christmas Hills, upper fauna, lat. 40° 54·1′ S., long. 144° 29·8′ E. 17, UT 92473, almost complete specimen, W form, ×10. 18, UT 92483, cephalon and thorax, W form, ×5·8.


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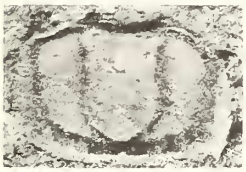
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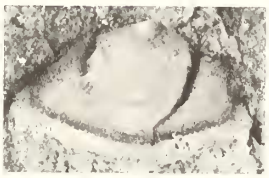
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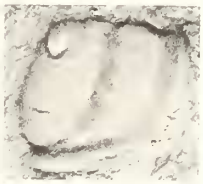
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JAGO, Tasmanian agnostids

rim wide, slightly elevated, and flatly convex; posterior marginal furrow wide and deep; both rim and marginal furrow narrow considerably to the anterior. Pygidial axis extends full length of acrolobe and in large specimens slightly on to the posterior marginal furrow. Narrow, smooth pleural fields. Lateral pygidial furrows are effaced; prominent node on second axial lobe.

Description. Moderately convex cephalon is about as wide as long. Cephalic margins converge gradually from the posterior to the broadly rounded cephalic front. Wide, shallow marginal furrow; narrow, flatly convex, slightly elevated rim. Both rim and furrow narrow posteriorly. Short, blunt posterolateral spines have a wide base. No preglabellar median furrow; smooth cheeks; moderately large simple, basal lobes.

Glabella is outlined by deep, moderately wide furrows; length about 0·7, and width about one-third, that of the cephalon. Shallow transverse glabellar furrow is arched posteriorly. Posterior glabellar lobe has length 0·7–0·75 that of glabella. On the holotype (UT 86599, Pl. 21, fig. 1) the glabellar rear is angular although the angularity is probably exaggerated by distortion (the glabellar rear is not properly visible on other cephala). Small centrally placed node on the posterior glabellar lobe.

Moderately convex pygidium is about as wide as long. From the anterior, the margins diverge slightly to short border spines placed about opposite axial posterior. Posterior margin is evenly curved between the spines. Wide, flatly convex, slightly elevated posterior rim; wide convex elevated lateral rim; wide deep marginal furrow. Both rim and furrow narrow markedly forwards. Narrow, shallow shoulder furrows; strongly geniculate shoulders with fulcra close to the axis; large, smooth, flat facets. Wide articulating furrow has a deep pit on either side of shallow central region. Narrow, convex articulating half-ring.

Wide, deep axial furrows; axis extends full length of acrolobe in mature specimens. In smallest available pygidium axial posterior is separated from posterior marginal furrow by a very short, shallow post-axial furrow. In larger specimens axis extends slightly on to marginal furrow.

Axis is slightly constricted in region of second axial lobe; lateral axial furrows are almost obsolete; well-developed node on second axial lobe. Anterior of node is a low ridge extending to anterior margin of acrolobe. Axial posterior is sharply rounded.

Discussion. P. gullini sp. nov. is quite close to *P. fallax minor* (Brögger), but differs in that it has a greater pygidial axial constriction, and the pygidial posterior is slightly more pointed. The pygidial axial rear reaches the posterior marginal furrow in all the larger specimens of *P. gullini* which is not the case with *P. fallax minor*. The basal lobes of *P. gullini* are larger than those of *P. fallax minor*. As noted above the pygidial axis of *P. gullini* extends further to the posterior in larger specimens than in smaller specimens.

Occurrence and age. Almost all specimens of *P. gullini* sp. nov. come from the lower fauna at Christmas Hills. There are four pygidia (including that figured as Pl. 21, fig. 9) tentatively assigned to *P. gullini* sp. nov. from the upper fauna at Christmas Hills. Thus *P. gullini* is probably of *Lejopyge laevigata* Zone I and possibly also extending into Zone II.

Peronopsis ekip sp. nov.

Plate 21, figs. 10–16

Material. Three partial cephala and four partial pygidia. All are well preserved.

Holotype. Pygidium UT 92689 (Pl. 21, fig. 15).

Diagnosis. Glabella has sharply rounded front and rounded rear. Transverse glabellar furrow arched strongly to the posterior. A small elongated glabellar node is placed towards glabellar posterior. Posterior glabellar lobe has a low anterior part and a relatively high posterior part. There is a vestigial preglabellar median furrow.

Subquadrate pygidium has a wide border, with short border spines. Almost parallel-sided, wide axis reaches the posterior marginal furrow; pygidial rear broadly rounded. Lateral axial furrows almost entirely effaced; axis slightly constricted at the second lobe. Prominent node on second lobe; small node towards axial posterior.

Description. Moderately convex cephalon about as long as wide. Moderately wide marginal furrow and moderately wide, slightly elevated, convex rim. Smooth cheeks. Glabella outlined by deep, wide axial furrows; it has a length about 0·7 that of the cephalon. Immediately anterior to sharply rounded glabellar front is a vestigial preglabellar median furrow which extends only a short distance towards the marginal furrow. Glabellar rear is rounded. Basal lobes, small, simple, and separated. Glabella expands slightly to the anterior; it is widest just behind the posteriorly arched transverse glabellar furrow. Anterior third of posterior glabellar lobe composed of two lobules which are outlined by faint furrows directed inwards and forwards from points on the axial furrows just to the anterior of the midpoint of the posterior lobe. The posterior glabellar lobe, particularly its posterior region, stands out strongly above the rest of the cephalon with the highest point being close to the posterior margin. Small elongated median node placed posteriorly on posterior glabellar lobe.

Subquadrate pygidium about as wide as long. Wide, shallow marginal furrow; wide, gently convex rim; short border spines. Gently geniculate shoulders with fulcra being close to the axis. Articulating furrow with a shallow central region and deep extremities. Convex articulating half-ring has a lenticular outline.

Pygidial axis distinctly convex and markedly elevated above less convex, smooth pleural fields. Axis is outlined by wide, moderately deep axial furrows which are subparallel for most of their length. Furrows shallow towards the bluntly rounded axial posterior which just reaches the marginal furrow. Axial width about two-fifths pygidial width. The two lateral axial furrows are effaced except for faint marginal indentations. Axis is slightly constricted at second lobe. The anterior and second lobes each have length about one-fifth that of axis. Very prominent node on second lobe. Small node occurs towards posterior of posterior axial lobe.

Discussion. The presence of a vestigial preglabellar median furrow may cast some doubt on the placing of this species in *Peronopsis*. However, the species described by Robison (1964, p. 531) as *Homagnostus incertus* has such a furrow, and as noted by Öpik (1967, p. 139), this species should be referred to *P. incerta* (Robison). *P. quadrata* (Tullberg), as illustrated by Westergård (1946, pl. 3, fig. 23), also shows a short preglabellar median furrow. Thus, the diagnosis of *Peronopsis* given by Robison (1964,

p. 529) should be amended to include forms with an incomplete preglabellar median furrow.

P. ekip sp. nov. has a small node placed towards the posterior of the pygidial axis; this feature is unique in *Peronopsis* as far as the author is aware.

Occurrence and age. P. ekip sp. nov. comes from near St. Valentines Peak; its age is either the *L. laevigata* III Zone or the *Damesella torosa–Ascionepea janitrix* Zone.

Genus HYPAGNOSTUS Jaekel, 1909

Hypagnostus Jaekel, 1909, p. 399; Kobayashi 1939, p. 122; Lermontova 1940, p. 129; Westergård 1946, p. 43; Ivshin 1953, p. 17; Howell 1959, p. 184; Öpik 1961*b*, p. 57; Robison 1964, p. 529; Öpik 1967, p. 82; Palmer 1968, p. 31.
Cyclopagnostus Howell, 1937, p. 1166; Howell 1959, p. 175.
Tomagnostella Kobayashi, 1939, p. 159; Howell 1959, p. 128.

Type species. Agnostus parvifrons Linnarsson, 1869, p. 82, pl. 2, figs. 56, 57.

Diagnosis. See Robison 1964, p. 529.

Discussion. Westergård (1946, p. 44) and later authors have included *Spinagnostus* Howell, 1935 in *Hypagnostus*. However, Shaw (1966, p. 848) redescribed the type species of *Spinagnostus*, *S. franklinensis* Howell, and concluded that *Spinagnostus* should be excluded from *Hypagnostus*. Shaw's interpretation is followed here until better-preserved examples of *S. franklinensis* clarify the situation.

Hypagnostus cf. *brevifrons* (Angelin)

Plate 21, figs. 17, 18

1946 Westergård, p. 48, pl. 5, figs. 24–29 (this reference gives the pre-1946 synonymy).
1959 Chu, p. 213, pl. 1, figs. 6–9.
1961*b* Öpik, p. 48, pl. 18, figs. 6–10.

Material. Two poorly preserved specimens are known from the upper fauna at Christmas Hills; one is an almost complete specimen; the other consists of a cephalon and a thorax.

Description. Moderately convex cephalon probably a little wider than long. Border consists of a moderately wide, flatly convex rim, and a narrow, shallow marginal furrow. Single lobed glabella has length about one-half that of cephalon, and at widest (at anterior of the small, simple basal lobes) it has a width about two-fifths that of the cephalon. Glabella tapers forward to well-rounded glabellar front. Basal lobes joined by narrow connecting band.

Moderately convex pygidium is probably slightly wider than long. It is widest at anterior and has a broadly rounded posterior margin. Border consists of wide, flatly convex rim and narrow, moderately deep marginal furrow. Border spines absent. Shallow, moderately wide shoulder furrows meet marginal furrows at an angle somewhat in excess of 90° and well to posterior of articulating furrow. Moderately convex shoulders with fulcra placed close to axis. Shallow articulating furrow is arched posteriorly; convex articulating half-ring. No post-axial median furrows developed; pleural fields smooth. Pygidial axis outlined by moderately deep and wide furrows. It has a fairly sharply rounded posterior and a length about 0·7 that of

the pygidium. Lateral axial furrows are obsolete; axis constricted in region of the second axial lobe on which there is an elongated node.

Discussion. The over-all appearance of the form described above is thus very similar to that of *Hypagnostus brevifrons* (Angelin) as described and illustrated by Westergård (1946, p. 48, pl. 5, figs. 24–29). However, the specimens of the form described above are about one-half the size of the largest Swedish and Queensland specimens of *H. brevifrons* as described and illustrated by Westergård (1946) and Öpik (1961*b*, p. 58) respectively. A further point is that the border of the pygidium of the Tasmanian specimen appears to be slightly wider than *H. brevifrons* as illustrated by both Westergård (1946) and Öpik (1961*b*). The preservation of the Tasmanian specimens is such that it cannot be seen if the glabellar node is present in the same position as those on the Swedish specimens illustrated by Westergård (1946, pl. 5, figs. 24, 25, 28). A feature seen on rubber casts of Westergård's specimens (pl. 5, figs. 27, 26 respectively) is the presence of a small node close to the posterior of the pygidial axis; this feature was not reported by Westergård. It is in a similar position to the posterior axial node of *H. correctus* Öpik (1967, text-fig. 16). Such a feature is too small to be preserved on the poorly preserved pygidium described above. It cannot be stated with certainty that these Tasmanian specimens belong to *H. brevifrons*, and thus they are referred to as *H.* cf. *brevifrons.*

Occurrence and age. H. cf. *brevifrons* (Angelin) comes from the upper fauna at Christmas Hills; its age is either of the *Lejopyge laevigata* I or II Zone.

Genus GRANDAGNOSTUS Howell, 1935

Grandagnostus Howell, 1935*a*, p. 221; 1959, p. 181; Öpik 1961*b*, p. 65 (part); Rasetti 1967, p. 37; Poulsen 1969, p. 7.
Phalacroma Kobayashi, 1939, p. 136 (part); Westergård 1946, p. 92 (part).

Type species. Grandagnostus vermontensis Howell, 1935*a*, p. 221, pl. 22, figs. 8–11.

Diagnosis. A very large agnostid in which both cephalon and pygidium are almost completely effaced. The cephalic border, if present, is extremely narrow. Small, subcentral node on cephalon. Subquadrate pygidium with wide border which narrows only slightly to anterior. Small circular node towards pygidial anterior. Articulating half-ring is a narrow strip covering more than half the width of the pygidium.

Discussion. See discussion of *Valenagnostus* gen. nov.

Grandagnostus sp.

Plate 22, figs. 1–5

Material. About twelve somewhat crushed specimens, all of which have undergone tectonic distortion; five of the specimens are more or less complete.

Description. Very large, almost entirely effaced cephalon slightly wider than long. Lateral cephalic margins quite steep, but rest of cephalon gently convex. Cephalon has circular outline with straight posterior margin. Border not visible on most specimens, but some cephala show traces of a very narrow border. On some specimens,

a narrow slightly upraised posterior rim and a narrow, shallow border are present on either side of a faintly outlined, rounded glabellar rear. Otherwise glabella is entirely effaced. Apparent centrally placed node on UT 92478 (Pl. 22, fig. 2) due to distortion.

Thoracic segments simple and have few furrows. Anterior thoracic segment decidedly longer (sag.) than posterior one.

Subsquare pygidium has evenly rounded posterior margin. Margins diverge slightly away from pygidial anterior until pygidium is widest about two-thirds of distance to posterior. Pygidium slightly wider than long. It is distinctly smaller than cephalon. This is shown well in all complete specimens and also in UT 86879g (Pl. 22, fig. 5), an enrolled specimen where the anterior end of the cephalon considerably overlaps the pygidial posterior. Almost flat pygidium has a wide border with a wide, gently convex rim, which narrows anteriorly and a wide, moderately deep marginal furrow. Shoulder furrows continuous with marginal furrows. Shoulder furrows narrow considerably adaxially; large flat facets; narrow shoulders. Articulating device not well preserved in any specimen, but in some poorly preserved unfigured specimens it is a narrow strip covering more than half the width of the pygidium. Shallow articulating furrow. Faint traces of moderately wide axis, of unknown length, at anterior of most pygidia. These traces are accentuated by the crushing of most pygidia.

Discussion. The specimens described above are not well enough preserved to be the basis for a new species. It is smaller than *G. glandiformis* (Angelin) and does not possess well-defined nodes as do *G. glandiformis* and *G. vermontensis*. However, such nodes would be difficult to see due to distortion.

Occurrence and age. Grandagnostus sp. comes from the upper fauna at Christmas Hills; its age is either of the *L. laevigata* I or II Zone.

Genus VALENAGNOSTUS nov.

Diagnosis. The almost entirely effaced cephalon has a narrow rim and a narrow marginal furrow. There is a small node on the posterior part of the cephalon. At the posterior of the pygidium the rim is wide and convex, and the marginal furrow is wide. The border narrows greatly to the anterior. A narrow, tapered vestigial axis extends to the marginal furrow; it is tapered most close to its anterior and again at about two-thirds of the distance of the posterior. There is a terminal axial node.

EXPLANATION OF PLATE 22

Figs. 1–5. *Grandagnostus* sp. Christmas Hills, upper fauna, lat. 40° 54·1′ S., long. 144° 29·8′ E. 1, UT 92477, complete specimen, W form, ×5. 2, UT 92478, complete specimen, intermediate distortion, ×8·7. 3, UT 86628, pygidium and thoracic segment, W form, ×5·2. 4, UT 86629, pygidium and two thoracic segments, W form, ×5·5. 5, UT 86879g, enrolled specimen, pygidium exposed, L form, ×5·3. Note the marked overlap of the cephalon with respect to the pygidium.

Figs. 6–11. *Valenagnostus banksi* sp. nov. from St. Valentines Peak, lat. 41° 21·6′ S., long. 145° 44·3′ E. 6, UT 92707, cephalon, L form, ×15·9. 7, UT 92720, cephalon, intermediate distortion, ×13. 8, UT 92693, pygidium and thoracic segments, W form distortion, ×19·2. 9, UT 92713, holotype pygidium, L form, ×20. 10, UT 92708, pygidium, W form, ×11·3. 11, UT 92688, pygidium, W form, ×11·5.

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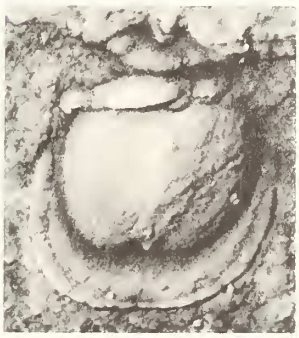

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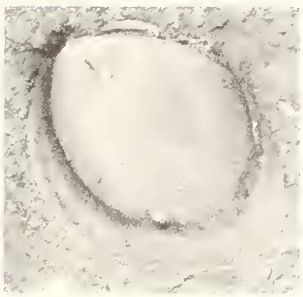

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JAGO, Tasmanian agnostids

Type species. Agnostus nudus Beyrich var. *marginata* Brögger, 1878, p. 73, pl. 6, fig. 3.

Discussion. The effaced agnostid species usually described under the generic names, *Phalacroma*, *Grandagnostus*, and *Phalagnostus* are difficult to assign to any particular genus. As noted by Öpik (1961*b*, p. 91), *Phalacroma* refers to agnostids with a wide, non-effaced pygidial axis like that of *P. bibullatum* (Barrande). Thus all species, which have both the cephalon and pygidium effaced and have been described as *Phalacroma*, must be reassigned to other genera.

Howell (1935*a*, p. 22) erected the genus *Grandagnostus* for a very large agnostid which has both the cephalic and pygidial acrolobes almost completely effaced, a wide pygidial border and a very narrow or absent cephalic border. In this genus, Howell (1935*a*) correctly included the type species, *G. vermontensis* Howell from Vermont and *A. glandiformis* Angelin from Sweden (see below). Unfortunately, *G. vermontensis* is poorly preserved. Westergård (1946, p. 96) refers to cephala of *glandiformis* up to 16 mm long and 15 mm wide.

There appear to me to be at least two and probably three distinct genera represented by the species included by Westergård (1946) in *Phalacroma*. Two of these genera are best compared by a comparison of *G. glandiformis* (Angelin) and *V. marginatus* (Brögger). The writer had at his disposal rubber casts of many of the specimens of both species that are illustrated by Westergård (1946, pls. 15, 16). Rubber casts of some of the specimens of *Phoidagnostus bituberculatus* (Angelin), *Phalacroma scanicum* (Tullberg), and *P. resectum* (Grönwall) illustrated in Westergård were also available.

The most obvious difference between *glandiformis* (Pl. 24, figs. 1–5 herein) and *marginatus* (Pl. 24, figs. 6–9 herein) is that the former is much larger. The narrow cephalic border of *marginatus* (Pl. 24, fig. 6) is much better developed than that of *glandiformis* (Pl. 24, fig. 2). Westergård (1946, p. 95) notes that no cephalon of *glandiformis* which has retained the exoskeleton shows a border, but in some of the exfoliated specimens (Pl. 24, fig. 2), including the lectotype, a narrow rim is visible.

The most marked differences of form are in the pygidia. The pygidial border of *glandiformis* (Pl. 24, figs. 3–5) consists of a very wide, shallow furrow and a gently convex rim. The rim is moderately wide at the posterior and quite narrow at the anterior. The border narrows slightly to the anterior. This is in marked contrast with the border of *marginatus* (Pl. 24, figs. 6–9). At the posterior the pygidial border of *marginatus* is very wide (in some specimens it has a length (sag.) over a quarter that of the complete pygidium). It consists of a narrow, shallow marginal furrow and a very wide, gently convex rim. The rim narrows greatly forwards where it is quite narrow; over all, the border narrows markedly forwards.

There is a faint but clear axis on *marginatus* which extends the full length of the acrolobe and has a terminal node. The axis of *marginatus* is very similar to that figured by Öpik (1961*b*, text-fig. 20) for his species *G. imitans*. The axis of *glandiformis* is poorly outlined, and there is no terminal node. The articulating half-ring of *glandiformis* is a narrow strip more than half the width of the pygidium, that of *marginatus* is lens-shaped and much less than half the width of the pygidium.

Howell (1955, p. 925) erected a new genus, *Phalagnostus*, with type species *Battus nudus* Beyrich in an attempt to solve the complex nomenclatural problem of the

effaced agnostids. Howell (1955, p. 926 states: '*Phalagnostus* differs from *Grandagnostus* in being smaller, in having a less quadrate pygidium, in having the node on the axial positions of the pygidium elongate, instead of circular and in having a more circular cranidium.'

Šnajdr (1958, p. 76) restudied the Czechoslovakian forms of *B. nudus* Beyrich and also revised the genus *Phalagnostus*. Šnajdr (1958, p. 78) included the following species in *Phalagnostus*, viz. *P. nudus* (Beyrich), *P. prantli* Šnajdr, *P. eskriggei* (Hicks), *P. scanicum* (Tullberg), *P. resectum* (Grönwall), *P. marginatus* (Brögger), and *P. glandiformis* (Angelin). The last four species are included by Westergård (1946) in *Phalacroma*. However, *marginatus* and *glandiformis* are shown above to belong to separate genera. The species *marginatus* and *nudus* are also considerably different, especially in the nature of the pygidial border, pygidial axis, terminal axial node, and cephalic border. They are regarded by the present writer as belonging to different genera. Species of the *marginata*-type are included below in the new genus *Valenagnostus*.

G. vermontensis Howell is poorly preserved and difficult to compare with other species. However, it would seem from a comparison of the photographs of *vermontensis* with rubber casts of some of the specimens of *G. glandiformis* (Angelin) illustrated in Westergård (1946) that *vermontensis* and *glandiformis* do belong in the same genus *Grandagnostus* Howell, as originally suggested by Howell (1935*a*). In fact, Poulsen (1969, p. 9) regarded *G. vermontensis* as a junior synonym of *G. glandiformis*, thus making the latter the type species. Shaw (1966, p. 848) described an incomplete cephalon as *G. vermontensis* Howell(?), the query being due to the lack of the cephalic node on Shaw's specimen. A well-preserved example of *vermontensis* is required before it can be decided whether or not it is conspecific with *glandiformis*.

Because Šnajdr (1958) included both species *nudus* and *glandiformis* in *Phalagnostus*, a comparison of the two species seems warranted. Apart from the rubber casts of *glandiformis* noted above, the author has at his disposal rubber casts of one pygidium of *nudus* (figured in Šnajdr 1958, pl. 5, fig. 9, and herein Pl. 24, fig. 11) and the holotype of *P. prantli* Šnajdr (1958, pl. 6, fig. 1), and herein Plate 24, fig. 10.

The species *glandiformis* is bigger than *nudus*; the cephalic posterior of *nudus* shows more traces of the glabellar rear and basal lobes than does that of *glandiformis*. The pygidial borders of *glandiformis* and *nudus* are similar in that they do not narrow much to the anterior. The pygidial rim of *nudus* is wider than that of *glandiformis* especially in the anterior region. The pygidia of *glandiformis* generally have a more quadrate outline than those of *nudus*. Another difference between the two species is in the arrangement of the pygidial muscle scars; those of *nudus* as illustrated by Šnajdr (1958, text-fig. 11) are smaller and more numerous than those of *glandiformis* illustrated by Westergård (1946, pl. 16, fig. 2) and herein Plate 24, fig. 4.

On each shoulder region of *nudus* there is a transverse furrow which extends across the anterolateral corner of the pygidium, across the anterior of the rim, and almost to the pygidial margin (Pl. 24, fig. 11). This furrow is distinct from the marginal furrow. No such furrow is seen in *glandiformis*. A similar furrow is also seen in *P. prantli* Šnajdr, *Phalacroma scanicus* (Westergård, 1946, pl. 14, figs. 16–18—see Pl. 24, figs. 15, 16) and in the species described by Hutchinson (1962, p. 90) as *P. nudum* (Beyrich).

Rasetti (1967, p. 38) considers that it is possible that this anterolateral transverse furrow is, in fact, the shoulder furrow and that the wide rim around the pygidium is part of the acrolobe. Poulsen (1969, p. 9) supports Rasetti's suggestion that the pygidium of *Phalagnostus* may not have a true border. Both Rasetti and Poulsen consider that the anterolateral transverse furrow described above is of generic significance. The writer agrees with this conclusion but feels that the question of the presence or absence of a border cannot be determined on the available material.

Öpik (1961*b*) referred two new species, *imitans* and *velaevis*, to *Grandagnostus*, and in 1967 (p. 86) he described *G. evexus*. Öpik (1961*b*, p. 54) states that there are two groups within *Grandagnostus*: (i) species without a cephalic marginal border, e.g. *G. velaevis*, and (ii) species with a border, e.g. *G. imitans*. Öpik (1961*b*, p. 67) differentiated between *Grandagnostus* and *Phalagnostus* on the grounds that the latter has no basal lobes. This appears to the writer to be an error. Basal lobes or traces of them are seen on all but the most effaced agnostid cephala and appear to be a fundamental part of agnostid anatomy. Furthermore, species such as *G. glandiformis* (Angelin) and *P. prantli* Šnajdr do possess vestigial basal lobes. This is shown by an inspection of a rubber cast of the cephalon of *glandiformis* (figured by Westergård 1946, pl. 15, fig. 4; herein Pl. 24, fig. 1) and a rubber cast, the complete holotype of *P. prantli* (figured by Šnajdr 1958, pl. 6, fig. 1; herein Pl. 24, fig. 10). The basal lobes of these species are difficult to see in the photographs noted above but are certainly present.

No comment can be made by the author on the species described by Pokrovskaya (1958) in *Phalacroma*, because the author has not seen that paper. The pygidium figured and described by Hajrullina (1962, p. 130, pl. 4, fig. 3) as *P. rabutense* cannot be compared in detail with other species because of the poorly reproduced photo of *rabutense*. *P. thorali* Howell (1935*b*, p. 227, pl. 22, figs. 19, 20) is poorly preserved and cannot be placed with certainty into any genus although its narrow pygidial border excludes it from *Grandagnostus*. Courtessole (1973) included this species in *Leiagnostus*, but the preservation of the figured specimens of *thorali* does not allow a definite generic assignment.

Öpik (1961*b*, p. 86) suggested, and Palmer (1968, p. 32) agreed, that *Agnostus bituberculatus* Angelin, 1851, belongs in *Phalagnostus*. However, *A. bituberculatus* has no transverse furrow near the anterolateral corners of the pygidium as has *Phalagnostus*, and should not be included in that genus.

My conclusions regarding the effaced agnostids are as follows:

(i) A new genus, *Valenagnostus* must be erected to include the following species, *V. marginatus* (Brögger), *V. imitans* (Öpik), *V. evexus* (Öpik); *V. banksi* sp. nov., and *V. brittoni* sp. nov., with *V. marginata* as the type species.

(ii) The other effaced agnostids usually described under *Grandagnostus*, *Phalacroma*, or *Phalagnostus* should be divided into at least two genera, i.e. *Grandagnostus* Howell, with *G. glandiformis* (Angelin) as the best-known species, and *Phalagnostus* Howell, with *P. nudus* (Beyrich) as type species. Other species which should be included in *Phalagnostus* are *P. prantli* Šnajdr and *P. scanicus* (Tullberg).

(iii) The generic position of *A. bituberculatus* Angelin, 1851 is not yet known.

(iv) The positions of the species *velaevis* and *resecta* (Pl. 24, fig. 12) are not known.

Valenagnostus banksi sp. nov.

Plate 22, figs. 6–11; text-fig. 1

Material. Many well-preserved, almost complete, pygidia. Unfortunately, only a few external moulds of almost complete cephala are known.

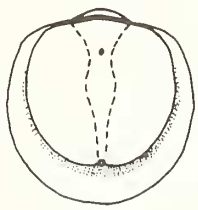
Holotype. Pygidium, UT 92713 (Pl. 22, fig. 9).

Diagnosis. Strongly convex, almost entirely effaced cephalon about as wide as long. Narrow cephalic border with short cephalic spines. Strongly convex pygidium about as wide as long. Wide border with wide elevated rim and moderately wide, shallow marginal furrow, both of which narrow greatly to the anterior. Faintly outlined axis has very prominent terminal node.

Description. Strongly convex cephalon about as wide as long. Narrow rim has similar slope to acrolobe margin and is separated from acrolobe by very narrow, shallow marginal furrow. Short cephalic spines known only from unfigured internal moulds. Cephalon is almost entirely effaced; glabella very faintly outlined at posterior and fades completely to anterior. Glabellar rear rounded. Small centrally placed node at posterior end of cephalon about one-third of distance from posterior to anterior margin. Posterior ends of basal lobes may be faintly outlined in UT 92707 (Pl. 22, fig. 6).

Strongly convex pygidium about as wide as long. Wide posterior border with wide elevated rim and a moderately wide, shallow marginal furrow. Both rim and marginal furrow narrow greatly anteriorly; near the anterolateral corners the border is quite narrow. Gently convex, narrow shoulders; narrow, shallow shoulder furrows. Basic articulating device with moderately deep articulating furrow which is arched slightly forward; lens-shaped articulating half-ring.

At centre of posterior margin border about one-fifth length of pygidium. Margins diverge slightly from anterolateral corners to a point just over half-way along pygidium; from this point posterior margin is broadly and evenly rounded. No border spines. The almost effaced narrow axis stands out very slightly above smooth pleural regions; it extends full length of acrolobe and has a prominent terminal node.



TEXT-FIG. 1. Pygidium of *Valenagnostus banksi* sp. nov.

In region of axial rear acrolobe is arched slightly forward. Axis moderately wide at anterior and tapers to posterior which is slight expansion at about midpoint (text-fig. 1). Small, centrally placed anterior axial node about one-quarter distance from anterior to posterior of axis. Axis shows no trace of annulation.

Discussion. The terminal pygidial axial node of *V. banksi* is much more prominent than those of other species of *Valenagnostus*. The pygidial marginal furrow of *V. banksi* is wider than that of either *V. imitans* or *V. marginatus*. Pygidia of *V. evexus* and *V. brittoni* are much more effaced than that of *V. banksi*.

Occurrence and age. V. banksi sp. nov. comes from near St. Valentines Peak; its age is of either the *Lejopyge laevigata* III Zone or the *Damesella torosa–Ascionepea janitrix* Zone.

Valenagnostus brittoni sp. nov.

Plate 23, figs. 1–6

Material. About fifty pygidia and cephala in varying states of preservation are available for descriptive purposes. Unfortunately, some of the best-preserved specimens are available only as internal moulds. It is on these specimens that the small cephalic spines can be seen. All figured specimens are external moulds.

Holotype. UT 86850c (Pl. 23, fig. 1).

Diagnosis. Cephalon almost effaced, with a narrow cephalic border and a small cephalic node. The pygidium has an extremely wide border which narrows greatly to the anterior. There is a faintly outlined axis with a small terminal node.

Description. Strongly convex cephalon about as wide as long. Narrow border with narrow, shallow marginal furrow and narrow convex rim. Slope of rim continuous with that of very steep acrolobe margin. Very small posterolateral spines. Margins of cephalon diverge slightly away from posterior margin; cephalon widest at mid-point; it has an evenly curved anterior margin. Cephalon almost entirely effaced with very faint traces of basal lobe posteriors and in some specimens vestiges of a moderately long and wide glabella (brought out by distortion and crushing of specimens). Cephalic node present.

Pygidium about as wide as long with acrolobe of slightly less convexity than that of cephalon. At posterior, border is very wide (about 0·3 length (sag.) of pygidium); wide, deep marginal furrow; wide, elevated convex rim. Border decreases in width considerably to anterior where it is quite narrow. Shoulder area not visible in many specimens; however, on an unfigured internal mould one shoulder is well exposed. Shoulder furrows are narrow and shallow; large concave facets; large fulcra placed about mid-way between anterolateral corners and centre of articulating device. Shallow, articulating furrow with slight depression at either end. Gently convex articulating half-ring. Faintly outlined pygidial axis extends full length of acrolobe; small axial terminal node. Small node at anterior end of axis about one-quarter of distance from anterior to posterior of axis. Axis wide at anterior (about 0·45 of

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EXPLANATION OF PLATE 23

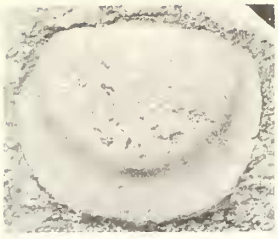
Figs. 1–6. *Valenagnostus brittoni* sp. nov. Christmas Hills, lower fauna, lat. 40° 54·1′ S., long. 144° 29·8′ E. 1, UT 86850c, holotype pygidium, W form, ×10·6. 2, UT 86869h, cephalon, intermediate distortion, ×7·4. 3, UT 86579, poorly preserved complete specimen, L form, ×9·5. 4, UT 86879m, cephalon, W form, ×10·4. 5, UT 86877, cephalon, L form, ×10. 6, UT 86870g, pygidium, W form, ×10.

Figs. 7–11. *Ptychagnostus* (*Goniagnostus*) *buckleyi* sp. nov. Christmas Hills, upper fauna, lat. 40° 54·1′ S., long. 144° 29·8′ E. 7, UT 86880i, cephalon, L form, ×11·4. 8, UT 92472, holotype, complete specimen, W form, ×8·5. 9, UT 86873a, W form, ×10·5. 10, UT 86872f, pygidium, W form, ×9. 11, UT 86880m, pygidium, L form, ×6·6.

Fig. 12. *Ptychagnostus* (*Ptychagnostus*) cf. *aculeatus* (Angelin). Christmas Hills, upper fauna, lat. 40° 54·1′ S., long. 144° 29·8′ E., pygidium, W form, ×14·7.

Fig. 13. *Utagnostus neglectus* sp. nov. Christmas Hills, lower fauna, lat. 40° 54·1′ S., long. 144° 29·8′ E. UT 86844i, holotype, complete specimen, intermediate distortion, ×11.

Figs. 14–17. *Utagnostus*(?) sp. from near St. Valentines Peak, lat. 41° 21·6′ S., long. 145° 44·3′ E. 14, UT 92718, cephalon and part of pygidium, ×19. 15, UT 92698, holotype, almost complete specimen, ×14·5. 16, UT 92686, pygidium, ×16. 17, UT 92699, cephalon and thorax, ×15.



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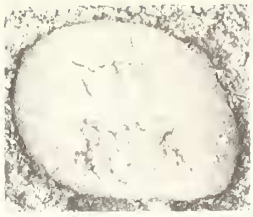

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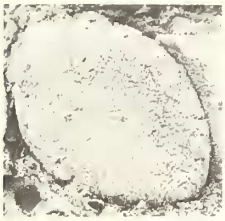

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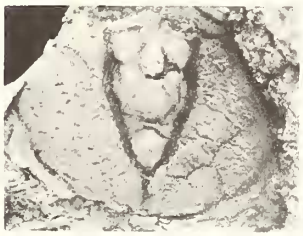

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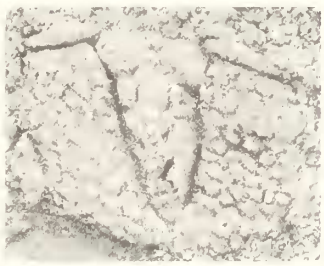

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JAGO, Tasmanian agnostids

pygidial width); immediately behind anterior margin axis narrows considerably and tapers evenly (except for a slight central widening) to terminal node.

Discussion. The pygidial border of *V. brittoni* is wider than those of *V. evexus*, *V. imitans*, and *V. banksi*. Some of the pygidia of *V. marginatus* figured by Westergård (1946, pl. 14 and herein Pl. 24, figs. 7–9) have a pygidial border of similar width to that of *V. brittoni*. However, these specimens are some of the smaller pygidia of *V. marginatus*, and the larger pygidia of *marginatus* have a narrower border than does *V. brittoni*. The pygidial axis of *V. brittoni* is less obvious than those of *V. banksi* or *V. marginatus*. *V. brittoni* does not have the elongate anterior axial node of *V. imitans*.

Occurrence and age. *V. brittoni* sp. nov. comes from the lower fauna at Christmas Hills; its age is probably of the *L. laevigata* I Zone.

Subfamily PTYCHAGNOSTINAE Kobayashi, 1939
Genus PTYCHAGNOSTUS Jaekel, 1909

Robison 1964, p. 522, gives the most detailed recent synonymy. The following synonymy should be added.

Ptychagnostus Šnajdr, 1958, p. 70; Pokrovskaya 1960, p. 58; Rushton 1966, p. 35; Palmer 1968, p. 28.
Goniagnostus Pokrovskaya, 1960, p. 58.
Doryagnostus Pokrovskaya, 1960, p. 58.
Triplagnostus Pokrovskaya, 1960, p. 58.

Diagnosis. See Robison 1964, p. 522.

EXPLANATION OF PLATE 24

Figs. 1–5. Rubber casts of *Grandagnostus glandiformis* (Angelin). 1 and 2, exfoliated cephalon figured by Westergård 1946, pl. 15, fig. 4. 1, top view, ×4·1. 2, side view showing very narrow rim, ×5·5. 3, pygidium from Andrarum Limestone, Kiviks-Esperöd, Scania figured by Westergård 1946, pl. 15, fig. 14, ×6. 4, pygidium showing muscle attachments from Andrarum Limestone, Andrarum, Scania, figured by Westergård 1946, pl. 16, fig. 2, ×2·4. 5, pygidium which has been damaged since figured by Westergård 1946, pl. 15, fig. 12, ×3·8.

Figs. 6–9. Rubber casts of *Valenagnostus marginatus* (Brögger). Specimens from Aborrtallet, Angermanland figured by Westergård as *Phalacroma marginatum* (Brögger). 6, cephalon figured by Westergård 1946, pl. 14, fig. 25, ×6·6. 7, pygidium figured by Westergård 1946, pl. 14, fig. 29, ×6. 8, pygidium figured by Westergård 1946, pl. 14, fig. 27, ×10. 9, pygidium figured by Westergård 1946, pl. 14, fig. 26, ×10.

Fig. 10. Rubber cast of the holotype of *Phalagnostus prantli* Šnajdr figured by Šnajdr 1958, pl. 6, fig. 1, ×7. Note the very faint traces of basal lobes.

Fig. 11. Rubber cast of enrolled specimen showing pygidium of *Phalagnostus nudus* (Beyrich), ×6·7. Originally figured by Šnajdr (1958, pl. 5, fig. 9). Note the arrangement of muscle scars and the furrow across the anterolateral corner of the pygidium.

Fig. 12. Rubber cast of pygidium of *Phalacroma resecta* (Grönwall) from Brantevik, Scania figured by Westergård 1946, pl. 14, fig. 19, ×6.

Figs. 13–14. Rubber casts of *Phalagnostus scanicus* (Tullberg) from Gislövshammer, Scania and Andrarum, Scania, respectively. 13, pygidium figured by Westergård 1946, pl. 14, fig. 18, ×8·5. 14, pygidium figured by Westergård 1946, pl. 14, fig. 17, ×8.

Figs. 15–16. Rubber casts of *Oidalagnostus trispinifer* Westergård, figured in Westergård 1946, pl. 9, figs. 7 and 6 respectively. 15, pygidium from Torbjorntrop, Västergotland, ×9. 16, holotype pygidium from Gudhem, Västergotland, ×5.

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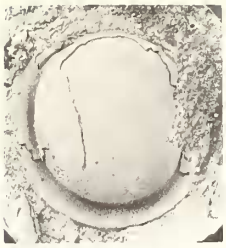

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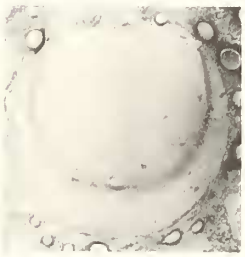

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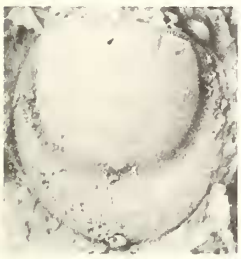

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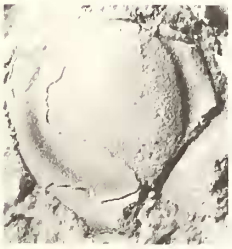

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JAGO, Tasmanian agnostids

Discussion. The Tasmanian forms add nothing to the concept of the genus *Ptychagnostus* as formulated by Öpik (1961*b*, p. 77). Any necessary discussion is given after the relevant species.

Ptychagnostus (*Ptychagnostus*) cf. *aculeatus* (Angelin)

Plate 23, fig. 12

Synonymy. See Palmer 1968, p. 28.

Material. One poorly preserved partial pygidium is known.

Description. Moderately convex pygidium with border almost entirely missing. Shoulder furrows of moderate width and depth; shoulders are narrow near lateral margins of pygidium and widen adaxially. Fulcra appear to be close to axis. Articulating device not visible. Axis outlined by moderately wide and deep furrows. Narrow, shallow post-axial median furrow appears to be present. Pleural fields covered with large granules. There also appear to be large tubercles on the first axial lobe, but they are much fainter than those on the pleural areas. Axial details are largely obscured. The axis is of the *P.* (*Ptychagnostus*) type. At anterior, axis has a width about two-fifths that of the acrolobe. From the anterior, axis narrows along first axial lobe which is tripartite, with the lateral lobules larger than the central lobule. First lateral axial furrow arched strongly forward. From anterior lobe axis tapers to the sharply rounded axial rear with a slight expansion at anterior of posterior axial lobe. Second axial lobe is also tripartite with the central lobule standing out above the lateral lobules; spine at posterior of central lobule. The poor preservation does not allow posterior extent of spine to be determined although there is a strong suggestion of quite a long spine. Posterior axial lobe slightly longer than the two anterior lobes combined.

Discussion. The Christmas Hills specimen has the following features in common with *P. aculeatus* (Angelin): (*a*) large granules over the pleural areas and on at least part of the axis, (*b*) a faint post-axial median furrow, and (*c*) a triannulated axis which may have quite a long spine.

P. aculeatus also exhibits closely spaced small granules over its surface. The Christmas Hills form does not show this feature clearly although there is a suggestion of it. The poor preservation makes retention of such features difficult. *P. aculeatus* has no border spines, but the border of the Christmas Hills specimen is not preserved and so this feature cannot be compared.

The contraction of the axis at the second axial lobe is not as marked as in the pygidia of *P. aculeatus* from Sweden, as illustrated by Westergård (1946, pl. 12, figs. 9 and 10), and from Queensland, as illustrated by Öpik (1961*b*, pl. 21, fig. 4*a*, *b*), but is similar to that figured from Alaska by Palmer (1968, pl. 6, fig. 20). The Tasmanian form is also smaller than those noted above. This fact may not be significant, but the faintness of the post-axial median furrow of the Tasmanian form may indicate that it is a quite mature specimen (see comment by Westergård 1946, p. 80). Thus, the Tasmanian form may be identical with *P. aculeatus* but it is too poorly preserved and incomplete to be sure.

If the Christmas Hills form is *P. aculeatus*, then the already widespread geographic

distribution of this species is extended. It is already known from Sweden, Norway, Alaska, and Queensland. Nowhere is it common, thus, limiting its use for correlation purposes. In Sweden it is 'everywhere infrequent' (Westergård 1946, p. 80); in Alaska Palmer (1968, p. 28) records a single pygidium, and in Queensland most of the specimens came from a single bedding plane (Öpik 1961*b*, p. 80).

In Sweden *P. aculeatus* is reported only from the *Solenopleura brachymetopa* Zone. In Queensland Öpik reports it from both the *P. cassis* Zone and the *Proampyx agra* Zone which extends its range up to about the middle of the Swedish *Lejopyge laevigata* Zone (Öpik 1961*b*, fig. 15). The exact age of the Alaskan fauna in which *aculeatus* was found was not determined by Palmer (1968), but it is of a similar age to both the Swedish and Queensland occurrences.

Occurrence and age. *P.* (*Ptychagnostus*) cf. *aculeatus* (Angelin) comes from the upper fauna at Christmas Hills; its age is either of the *L. laevigata* I Zone or the *L. laevigata* II Zone.

Ptychagnostus (*Goniagnostus*) *buckleyi* sp. nov.

Plate 23, figs. 7–11

Material. One very well-preserved external mould of an almost complete specimen, plus about twenty separate pygidia and cephala preserved as external moulds.

Holotype. UT 92472, Plate 23, fig. 8.

Diagnosis. *P. buckleyi* sp. nov. has moderately long, slightly divergent posterolateral spines on both cephalon and pygidium. Cephalic axial furrows and scrobiculae are moderately deep. Narrow cephalic border; somewhat wider pygidial border. Pygidium has large shoulders and a shallow post-axial median furrow. Pygidial pleural areas covered with closely spaced small nodes.

Description. Gently convex cephalon probably a little wider than long. Narrow border with narrow, shallow marginal furrow and narrow, convex elevated rim. Posteriorly directed, slightly divergent posterolateral spines with thick bases extend to points opposite the junction of the thoracic segments.

Length of glabella about three-quarters that of cephalon. Glabella outlined by narrow, moderately deep furrows; narrow, shallow preglabellar median furrow. Almost straight transverse glabellar furrow with a slight forward deflection at centre and at either extremity. Anterior glabellar lobe is subtriangular and has a length about two-fifths that of glabella.

Posterior glabellar lobe is trilobate (including basal lobes); it has two pairs of deep lateral furrows which are directed inwards and slightly backwards from the axial furrows. Each furrow extends about one-quarter of distance across glabella. Anterior pair deeper than posterior pair. Posterior furrows (each with a deep adaxial pit) mark anterior of basal lobes. Basal lobes have length about one-third of posterior glabellar lobe. Very narrow rim beneath wide, broadly rounded glabellar rear connects posterior rims and is separated from basal lobes by narrow, shallow furrows. There is a marked decrease in width of glabella at transverse glabellar furrow.

On each highly scrobiculate cheek is a primary scrobicule which runs outwards and slightly forwards from a point near the end of the transverse glabellar furrow.

(On UT 92472, Pl. 23, fig. 8, this scrobicule appears to meet the transverse glabellar furrow, but this is a tectonic effect.) To the anterior of this scrobicule on each cheek there are three primary rugae. Scrobiculae show a radial distribution with secondary scrobiculae of various lengths between the main scrobiculae. The posterior portions of the cheeks have three or four primary rugae which are not as well defined as those in anterior part of cheeks. All these scrobiculae tend to be deepest adaxially. There is a pair of short scrobiculae in adaxial region of cheeks; each member of the pair arises from the axial furrow near anterior end of middle glabellar lobe.

Gently convex pygidium probably slightly wider than long. Pygidial border wider than cephalic border; narrow, shallow marginal furrow; moderately wide, gently convex rim. Moderately long, slightly divergent border spines; border width increases near spine bases which are about opposite end of pygidial axis. Narrow, shallow shoulder furrows; large shoulders; facets not clearly preserved but appear to be quite big; fulcra placed just abaxial of midpoints between anterolateral corners and axial furrows. Articulating furrow shallowest at centre; it is arched backwards. Small, low, convex articulating half-ring.

Pleural areas separated behind axis by narrow, shallow post-axial median furrow. Pleural areas apparently have a closely spaced reticulate veination. However, this feature is probably caused by distortion of closely spaced, small nodes. Wide, deep axial furrows. Length of axis about three-quarters that of pygidium.

Quadrilobate axis is constricted at anterior lateral furrow. Bluntly pointed axial rear. Tripartite anterior lobe with lateral lobules extending slightly more to both posterior and anterior than the central lobule. Narrow, moderately deep, anterior lateral furrow is arched slightly forward at its centre. Lateral lobules slightly wider (tr.) than the central lobule. Second lobe is tripartite with strong node on central lobule. Central lobule extends markedly to posterior so that middle transverse axial furrow is arched strongly to the posterior at the centre. Second axial lobe is slightly larger than anterior lobe. Third and fourth axial lobes are somewhat more convex than the anterior lobes; they are divided by a wide, deep furrow which is narrowest at its centre. Axis is slightly constricted at this furrow. Small node at centre of this furrow.

Discussion. This species clearly belongs in *P.* (*Goniagnostus*) as defined by Öpik (1961*b*, p. 77). The cephalic scrobiculae of *buckleyi* are deeper than those of *P.* (*G.*) *nathorsti* (Brögger), the type species of the subgenus. The pygidial border spines of *buckleyi* are much larger than those of *nathorsti*. The larger cephalic posterolateral spines in *buckleyi* are similar to those figured for *P.* (*G.*) *fumicola* Öpik (1961*b*, text-fig. 28). *P. buckleyi* has a distinct post-axial median furrow whereas the pygidium of *fumicola* has no such furrow.

The pygidial pleural areas of *buckleyi* are covered by closely spaced, small nodules; those of *fumicola* are covered by coarse granules. The pygidial pleural areas of the Mindyallan *P.* (*G.*) *nodibundus* are also covered with coarse granules (Öpik 1967). The pygidial border spines of *P.* (*G.*) sp. aff. *nathorsti*, illustrated by Öpik (1961*b*, text-fig. 30), and of *P.* (*G.*) cf. *nathorsti*, Whitehouse (1939, p. 259, pl. 25, fig. 20), are much smaller than those of *buckleyi* as are those of *G.* aff. *nathorsti* of Chu (1965, p. 13, pl. 1, figs. 4–7). The pygidial pleural areas of this Chinese form appear to be

smooth in contrast to those of *buckleyi*. The pygidium illustrated by Chu (1965, pl. 1, fig. 8) as *Goniagnostus* sp. is similar to that of *buckleyi* in that they both appear to have closely spaced, small nodes which are partly confluent. However, *buckleyi* has larger shoulders and bigger border spines.

The species described by Whitehouse (1939, p. 258, pl. 25, figs. 21–23) as *G. purus* belongs to *P.* (*Ptychagnostus*) rather than to *P.* (*Goniagnostus*). The fact that the pygidial axis is trilobed can be seen in plate 25, fig. 23 of Whitehouse. However, Whitehouse (p. 259) clearly recognized that *purus* is close to *P.* (*P.*) *gibbus* and questioned the differentiation of *Goniagnostus* and *Ptychagnostus* on the basis of the former having pygidial spines. Westergård (1946, p. 80) raised the same query. Westergård (1946, p. 81) included *scanensis* in *Goniagnostus* presumably on the basis of the small pygidial spines on this species. Only two pygidia of this species were known to Westergård, and he states (p. 82), 'the transverse depression across the end-lobe is very weak'. A close inspection of a rubber cast of the specimen figured by Westergård (1946, pl. 12, fig. 17) reveals no such depression, and thus *scanensis* probably belongs to *P.* (*Ptychagnostus*) rather than *P.* (*Goniagnostus*).

The species described by Whitehouse (1939, p. 260, pl. 25, fig. 19) as *G. scarabaeus* is difficult to compare with *buckleyi* due to the poor photographic reproduction of *scarabaeus*. The description by Whitehouse (1939, p. 260) notes, 'there are three or four pits on either side of the posterior glabellar lobe and one on each side of the anterior lobe'. These features are not seen in *buckleyi*. Whitehouse (1939, p. 260) gives a small line diagram of *scarabaeus* in which there is no sign of a fourth axial lobe. On the other hand, he states that *scarabaeus* is perhaps closer to *nathorsti* than it is to other members of *Goniagnostus*. This may indicate that the pygidial axis is quadri-lobed and that *scarabaeus* belongs to the subgenus *Goniagnostus*. The photograph reproduced in Whitehouse (1939, pl. 25, fig. 19) is not clear on this point.

P. (*G.*) *spiniger* (Westergård) has large diverging posterolateral spines which appear slightly more divergent than those of *buckleyi* although this may be due to different preservation. However, the main difference between *spiniger* and *buckleyi* is that the pygidial axis of *spiniger* narrows all the way to its posterior. In *buckleyi* the third axial lobe is distinctly wider than the second axial lobe.

The specimen figured by Howell (1935*c*, figs. 3, 4) as *G. confluens* (Matthew) appears to belong to *P.* (*Ptychagnostus*) rather than *P.* (*Goniagnostus*). *P. confluens* is trilobed, and the apparent quadrilobation in Howell's photograph appears to be due to distortion.

Occurrence and age. *P.* (*G.*) *buckleyi* sp. nov. comes from the upper fauna at Christmas Hills; its age is late middle Cambrian, probably of the *L. laevigata* I Zone or the *L. laevigata* II Zone.

Family CLAVAGNOSTIDAE Howell, 1937
Subfamily ASPIDAGNOSTINAE Pokrovskaya, 1960
Genus ASPIDAGNOSTUS Whitehouse, 1936

Aspidagnostus Whitehouse, 1936, p. 104 (cephalon only); Kobayashi 1939, p. 164 (cephalon only); Howell 1959, p. 173 (cephalon only); Pokrovskaya 1960, p. 61 (cephalon only); Palmer 1962, p. 14; Öpik 1967, p. 115; Lu 1974, p. 79.

Type species. Aspidagnostus parmatus Whitehouse, 1936, p. 105, pl. 9, fig. 5 only.

Diagnosis. See Öpik 1967, p. 116 (except for character 5).

Aspidagnostus sp.

Plate 25, figs. 1–5

Material. Three cephala and four pygidia are available for description.

Description. Moderately convex cephalon is about as wide as long. Narrow, shallow marginal furrow; narrow, convex rim. Posterolateral corners not seen clearly in any specimen. (The apparent spine in UT 92731 (Pl. 25, fig. 2) is an artifact of preservation.) Moderately large, simple basal lobes. Glabella outlined by wide, deep furrows. Preglabellar median furrow exceedingly variable in the three available specimens. In specimens UT 92701 (Pl. 25, fig. 3) and UT 92731 (Pl. 25, fig. 2) there is a well-developed preglabellar median furrow; in specimen UT 92732 (Pl. 25, fig. 1) there is hardly any sign of a preglabellar median furrow.

Single-lobed glabella well elevated above smooth cheeks. Glabellar rear angular and somewhat drawn out perhaps with an occipital collar, but this feature cannot be seen clearly. Glabella expands slightly forwards for most of its length; bluntly pointed glabellar front. Centrally placed, low ridge which extends about half length of glabella.

Zonate pygidium may be slightly wider than long. Narrow, shallow marginal furrows; narrow, convex, elevated lateral rims; median length border spines. Deep, narrow gap in pygidial collar. On either side of the gap is a strong knob. Immediately behind gap is a depressed flange bearing a median spine. At anterior of flange between posterior ends of collar knobs is a small deep pit.

Articulating device consists of a shallow articulating furrow which is arched to the posterior and an elevated articulating half-ring which does not extend full width of axis. Narrow, shallow shoulder furrows; shoulders are nowhere well preserved. Smooth pleural fields.

Very deep clavagnostid pits (*Clavagnostus* pits of Öpik 1967; clavagnostid pits of Jago and Daily 1974) about two-thirds of the distance from anterior to posterior of axis. Pits are contained in a deep depression which extends right across the axis with only a slight central ridge between the pits. Posterior one-third of axis depressed

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EXPLANATION OF PLATE 25

Figs. 1–5. *Aspidagnostus* sp. from near St. Valentines Peak, lat. 41° 21·6′ S., long. 145° 44·3′ E. 1, UT 92732, cephalon, W form, ×21. 2, UT 92731, cephalon, L form, ×22. 3, UT 92701, partial cephalon, ×22. 4, UT 92729, pygidium, W form, ×23. 5, UT 92732, pygidium, W form, ×23.

Figs. 6–9. *Diplagnostus* sp. from upper fauna at Christmas Hills, lat. 40° 54·1′ S., long. 144° 29·8′ E. 6 and 7, UT 86872c, 6, cephalon, W form, ×18; 7, internal mould of same specimen, ×21. 8, UT 92482, pygidium, W form, ×19. 9, UT 86872n, flattened cephalon, W form, ×18.

Figs. 10–16. *Tasagnostus compani* sp. nov. from near St. Valentines Peak, lat. 41° 21·6′ S., long. 145° 44·3′ E. 10, UT 92711, complete specimen with cephalon skewed with respect to the pygidium, ×6·3. 11, holotype pygidium, W form, ×14. 12, UT 92709, cephalon, W form, ×7·5. 13, UT 92717, cephalon, L form, ×8. 14, UT 92705, partial pygidium, ×13·6. 15, UT 92725, pygidium, intermediate distortion, ×16·5. 16, UT 92700, pygidium, internal mould, ×9·4.

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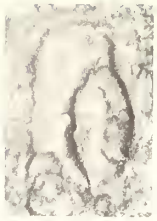

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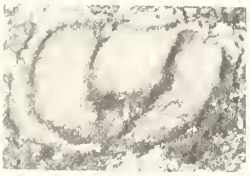

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JAGO, Tasmanian agnostids

slightly below pleural fields. No distinct lobes on anterior part of axis. Strong central keel extends entire length of axis in front of the pits; it is most prominent towards its posterior.

At anterior, axis has width about 0·45 that of pygidium. Immediately behind anterior end of axis it narrows sharply to give a sharp axial constriction; from this constriction the axis widens slightly to about its midpoint from where axis narrows sharply to clavagnostid pits. At pits axis has width between one-quarter and one-third that of pygidium. From the pits axial furrows are straight and converge evenly to pointed axial posterior. Axis extends entire length of acrolobe but does not quite extend as far to posterior as do the pleural fields.

Discussion. The species described above is tentatively placed in *Aspidagnostus*. It conforms with *Aspidagnostus*, as defined by Öpik (1967, p. 116) except that the basal lobes are simple and it has no median ogive on the anterior cephalic border. On the basis of these differences, it seems unnecessary to the writer to erect a new genus in which to place the species from St. Valentines Peak. A further factor is that both *A. laevis* and *A. rugosus* (Palmer 1962, p. 15) appear to have simple basal lobes. This is recognized by Öpik (1967, p. 120, fig. 30) for *laevis*. This is in contrast to Öpik's statement (1967, p. 116) that one of the diagnostic characters of *Aspidagnostus* is the presence of composite basal lobes.

The cephalon (UT 92731) of *Aspidagnostus* sp. (Pl. 25, fig. 2) shows an apparently well-developed preglabellar median furrow. This furrow may have been exaggerated by distortion but it appears to be genuine. On the other hand, UT 92732 (Pl. 25, fig. 1) shows no trace of a preglabellar median furrow. This may simply be intraspecific variation or there could be two species of *Aspidagnostus* present. However, at present, with the limited material available the writer prefers to place all the specimens in the one species.

Aspidagnostus sp. occurs in a late middle Cambrian fauna and is thus the oldest known species of *Aspidagnostus*. It is possible that *Aspidagnostus* sp. represents an ancestral form of the species of *Aspidagnostus*, described by Öpik (1967) and Palmer (1962), with the later forms developing a median ogive.

Occurrence and age. Aspidagnostus sp. comes from the fauna near St. Valentines Peak; its age is late middle Cambrian, the *L. laevigata* III Zone, or the *Damesella torosa–Ascionepea janitrix* Zone.

Family DIPLAGNOSTIDAE Whitehouse, 1936
Subfamily DIPLAGNOSTINAE Whitehouse, 1936
Genus DIPLAGNOSTUS Jaekel, 1909

Diplagnostus Jaekel, 1909, p. 396; Kobayashi 1939, p. 140; Westergård 1946, p. 61; Rusconi 1952, p. 10; Hupé 1953, p. 63; Howell 1959, p. 175; Pokrovskaya 1960, p. 57; Poulsen 1960, p. 10; Öpik 1961*a*, pp. 415 ff.; 1961*b*, p. 69; 1967, p. 126; Hutchinson 1962, p. 78; Chu 1965, p. 135; Poulsen 1969, p. 4.

Enetagnostus Whitehouse, 1936, p. 91; (*non* Lermontova 1940, p. 128).

Type species. Agnostus planicauda Tullberg, 1880 (*non* Angelin, 1851).

Diagnosis. See Öpik 1961*b*, p. 69.

Diplagnostus sp.

Plate 25, figs. 6–9

Material. One very poorly preserved almost complete specimen, six cephala, and six pygidia are available for description. All are poorly preserved.

Description. Moderately convex cephalon probably slightly wider than is long. Narrow, shallow marginal furrow; narrow, convex rim. Well-defined preglabellar median furrow shallows anteriorly. Deep axial furrows. Cheeks are probably smooth (the poor preservation makes this difficult to determine, but on most specimens the corrugations appear to be distortion effects). Glabella is about three-quarters the length and one-third the width of cephalon. Subrectangular anterior glabellar lobe contains a narrow sulcus which extends about one-third of way into the lobe. Transverse glabellar furrow is almost straight; it is arched slightly to the posterior for most of its length but is bent slightly forward at its centre. On posterior glabellar lobe is a pair of shallow, lateral furrows which turn inward and forwards from points on the axial furrows which are a little to the anterior of the centre of the lobe. High, wide, central ridge extends along anterior and central parts of posterior glabellar lobe. Angular glabellar rear; small, simple basal lobes.

Zonate pygidium probably slightly wider than long. Narrow marginal furrow; narrow, convex rim is widest at posterior. Articulating device is nowhere preserved. Narrow, shallow shoulder furrows; narrow, convex, moderately geniculate shoulders; fulcra are close to axis. Small border spines. Smooth pleural areas. Pygidial axis has length about two-thirds that of pygidium. Narrow, moderately deep axial furrows. Distinct gap between the sharply rounded pygidial posterior and the collar. There may be a faint post-axial median furrow. Narrow, shallow anterior lateral axial furrow directed inwards and forwards from either end. Posterior lateral furrow is poorly developed. Median keel about a quarter the width of axis. It extends from anterior of axis across the anterior two lobes and just on to the posterior axial lobe. Keel is highest and widest near posterior of second axial lobe. First two axial lobes are of about equal length (sag.) and together make up about 0·4–0·45 of the total axial length. Axis slightly constricted at second axial lobe. Collar seems to join rim at its extremities, which are well forward of the spines.

Discussion. The species of *Diplagnostus* described above from Christmas Hills differs from *D. planicauda vestgothicus* (Wallerius) and *D.* cf. *p. vestgothicus* (Öpik, 1961*b*, p. 71) in that these species have highly scrobiculate cephala. The pygidial axis of *D. planicauda* (Angelin) is wider than that of the Christmas Hills form. The preglabellar median furrow of the *Diplagnostus* described above is better developed than that of *D. p. bilobatus* Kobayashi. The preglabellar median furrow of *D. jarillensis* Rusconi is deeper than that of the Christmas Hills form, and *jarillensis* also has a more rounded glabellar front. The preglabellar median furrow and marginal furrows of *D. humilis* (Whitehouse) are wider and deeper than those of the species described above. *D. crassus* Öpik differs from the Christmas Hills species in that it has a broadly rounded glabellar rear.

Thus, the *Diplagnostus* found at Christmas Hills differs from all known species.

However, there are not enough well-preserved specimens to erect a new species, and it is referred to as *Diplagnostus* sp.

Occurrence and age. Diplagnostus sp. comes from the upper fauna at Christmas Hills; its age is either of the *L. laevigata* I Zone or the *L. laevigata* II Zone.

Subfamily OIDALAGNOSTINAE Öpik, 1967

The Subfamily Oidalagnostinae was defined by Öpik (1967, p. 134). A new genus, *Tasagnostus* is included herein in this subfamily. The genus *Ovalagnostus* Lu also belongs in the Oidalagnostinae. The author feels that character (2) of the subfamily (see Öpik 1967) should read, 'the median depression in the pygidial collar' rather than 'median gap'. This is because there is no distinct break in the collar of any known species of *Tasagnostus*, *Oidalagnostus*, or *Ovalagnostus* such as there is in *Aspidagnostus*.

Genus OIDALAGNOSTUS Westergård, 1946

Oidalagnostus Westergård, 1946, p. 65; Hupé 1953, p. 63; Howell 1959, p. 175; Pokrovskaya 1960, p. 57; Öpik 1967, p. 134; Lu 1974, p. 79.

Type species. O. trispinifer Westergård, 1946, p. 65, pl. 9, figs. 4–7.

Discussion. Öpik (1967, p. 134) has discussed fully the generic concept of *Oidalagnostus*. The author has at his disposal rubber casts of the two pygidia of *O. trispinifer* figured by Westergård. They are the specimens figured by Westergård as plate 9, figs. 6 and 7. The holotype (Pl. 24, fig. 16) is an exfoliated specimen, and thus shows the internal anatomy better than does the other specimen (Pl. 24, fig. 15), which has the original test preserved.

An inspection of the holotype (Pl. 24, fig. 16) reveals the presence of a long, low, rounded ruga on each pleural area. These rugae extend from near the junction of the two lateral bosses to a point near the anterolateral corners. This photograph also shows that the pleural areas are much more pitted on the abaxial sides of these rugae than on the adaxial side. An inspection of the pygidium of *O. personatus* Öpik (1967, pl. 54, fig. 8) shows what appears to be similar rugae. This type of pygidial caecal arrangement may be indicative of *Oidalagnostus*.

O. personatus Öpik from the Queensland *Lejopyge laevigata* II Zone has one pair of lateral bosses on the third axial annulation. The younger *O. trispinifer* Westergård has two well-developed lateral bosses on the posterior part of the pygidium. In Queensland *O. trispinifer* extends from the *L. laevigata* III Zone to the *Cyclagnostus quasivespa* Zone. In Sweden *trispinifer* is found in the upper part of the Swedish *L. laevigata* Zone.

The older species of *Tasagnostus*, i.e. *T. debori*, from the lower fauna at Christmas Hills is of about *L. laevigata* I age and has no distinct lateral bosses on the third pygidial axial annulation. In contrast, the younger, *T. compani* (about *L. laevigata* III age), from near St. Valentines Peak has distinct lateral bosses on the third pygidial axial annulation. Thus, in the known species of *Tasagnostus* and *Oidalagnostus* there is a trend to increase the differentiation of the lateral bosses in the younger species.

The close similarity of the pygidial structure of *Tasagnostus* or *Oidalagnostus* makes it appear probable that *Oidalagnostus* arose from *Tasagnostus* or a *Tasagnostus*-like agnostid by extension of the pygidial rim into a median spine.

Genus TASAGNOSTUS nov.

Type species. T. debori sp. nov.

Diagnosis. Cephalon with smooth cheeks; wide marginal furrow; wide, convex elevated rim. There is usually an incomplete preglabellar median furrow; deep axial furrows; shallow transverse glabellar furrow. Simple basal lobes; angular glabellar rear; small, wide posterolateral spines.

Zonate pygidium has a wide border and a pair of small border spines. In some specimens there is a transversely elongated pair of knobs on the collar directly behind the axis; knobs are separated by a low depression. Axis extends to the collar; it is divided into two parts by a pair of broad and deep laterally elongated pits found in the posterior part of axis. Anterior to these pits are three axial lobes, on which is an elongated ridge which is much lower on the third lobe than on the anterior pair. Axis widens considerably posterior to second axial lobe and is widest near the lateral pits. There is a low intranotular axis in the wide posterior segment of the axis.

Discussion. Tasagnostus has a zonate pygidium and is rather similar to *Oidalagnostus*. The genera are differentiated by the fact that *Tasagnostus* has two border spines whereas *Oidalagnostus* has a trispinose pygidium. *T. compani* sp. nov., described below, from near St. Valentines Peak has gently pitted pleural fields. The diagnosis given above and this latter fact show that *Tasagnostus* clearly belongs in the Subfamily Oidalagnostinae as defined by Öpik (1967, p. 134).

Oedorhachis Resser and *Baltagnostus* Lochman differ from *Tasagnostus* in that they have only three pygidial axial annulations whereas *Tasagnostus* has four annulations. *Dolichagnostus* Pokrovskaya differs from *Tasagnostus* in having a much better-defined preglabellar median furrow and a much less well-defined quadrilobation of the pygidial axis. The pygidium of *Dolichagnostus* has a constricted acrolobe whereas that of *Tasagnostus* is unconstricted. The posterior pygidial margin of *Dolichagnostus* is angulate; that of *Tasagnostus* is evenly rounded. *Oidalagnostus? dubius* Westergård is related to *Dolichagnostus* (Öpik 1967, p. 132), but differs from both *Dolichagnostus* and *Tasagnostus* in having a median pygidial spine.

The only figured specimen of the type species of *Ovalagnostus*, *O. changi* (see Lu *et al.* 1974, p. 82, pl. 1, fig. 8) is rather poorly preserved. However, it appears that the pygidial collar of *O. changi* is placed much further forward than in *Tasagnostus*; the marginal furrows (particularly in the pygidium) of *O. changi* are considerably wider than those of either species of *Tasagnostus*. The transverse glabellar furrow of *O. changi* appears to be much deeper than in either species of *Tasagnostus*. It cannot be determined from the photographs given in Lu *et al.* (1974) if *O. changi* has a third pygidial spine. It is possible that *Tasagnostus* could be placed in synonymy with *Ovalagnostus*. However, until better-preserved specimens of *O. changi* are available, I prefer to place the Tasmanian forms in a separate genus.

Tasagnostus debori sp. nov.

Plate 26, figs. 1–13

Material. The illustrated specimens are selected from the hundreds of available specimens.

Holotype. Pygidium, UT 86869e (Pl. 26, fig. 1).

Diagnosis. Cephalon in which preglabellar median furrow usually incomplete. Shallow transverse glabellar furrow; angular glabellar rear; large, simple basal lobes. Zonate pygidium may have a very low pair of transversely elongated knobs on collar. Smooth pleural areas. Broadly rounded pygidial axis extends slightly on to posterior marginal furrow. A little to the posterior of the centre of the axis is a lateral furrow with a pair of pits, one on each side of a low central rise. This furrow does not quite extend right across axis and at either extremity is distinctly separated from the axial furrow.

Description. Cephalon about as wide as long. Border wide at anterior, narrows markedly to posterior. Rim is wide, convex, and elevated at anterior, becoming narrow posteriorly. Wide, moderately deep marginal furrow narrows posteriorly. Cephalon has subparallel margins in posterior half and a broadly rounded anterior outline. Deep, wide axial furrows. Glabella has length about 0·7 that of cephalon. Glabellar front may be slightly pointed. Preglabellar median furrow is generally incomplete being widest and deepest at the posterior and fading to the anterior. Angular glabellar rear; large, simple basal lobes extend about one-third of way to glabellar front. From anterior ends of basal lobes to shallow transverse glabellar furrow the glabella is parallel sided with a slight increase in width just behind the furrow. Transverse furrow arched gently backwards. Long, narrow, node placed just forwards of centre of glabella. At transverse furrow, glabella has a width just under one-third that of cephalon. Smooth cheeks. No connective band behind glabella. Short, wide, blunt posterolateral spines arise from wide bases.

EXPLANATION OF PLATE 26

Figs. 1–13. *Tasagnostus debori* sp. nov. 1–12 from Christmas Hills, lower fauna and 13 from Christmas Hills, upper fauna, lat. 40° 54·1′ S., long. 144° 29·8′ E. 1, UT 86869e, holotype pygidium, W form, ×7·4. 2, UT 86869d, pygidium, W form, ×7·4. 3, UT 86877f, pygidium showing slightly raised intranotular axis, intermediate distortion, ×12·2. 4, UT 86877e, cephalon, L form, ×9·3. 5, UT 86869d cephalon, intermediate distortion, ×12. 6, UT 86856n, cephalon, intermediate distortion, ×7·3. 7, UT 92467, pygidium and thorax, L form, ×7·8. 8, UT 86877d, immature pygidium, W form, ×7·9. 9, UT 86877e, cephalon intermediate distortion, ×7·7. 10, UT 92480, pygidium, intermediate distortion, ×6·1; note the furrows outlining the intranotular axis, which have been accentuated by distortion. 11, UT 86846, cephalon, W form, ×11·2. 12, UT 86869g, pygidium, W form, ×10. 13, UT 86879e, pygidium, intermediate distortion, ×8·9.

Fig. 14. Agnostid, gen. et sp. indet. no. 1, from St. Valentines Peak, lat. 41° 21·6′ S., long. 145° 44·3′ E., pygidium, ×25.

Fig. 15. Agnostid, gen. et sp. indet. no. 2, from St. Valentines Peak, lat. 41° 21·6′ S., long. 145° 44·3′ E., pygidium, ×12.

Fig. 16–19. Agnostid, gen et sp. indet. no. 3, from upper fauna, Christmas Hills, lat. 40° 54·1′ S., long. 144° 29·8′ E. 16, UT 86620, complete specimen, W form, ×6. 17, UT 86878m, cephalon, W form, ×8. 18, UT 86620, cephalon, W form, ×8·2. 19, UT 86880c, pygidium, W form, ×14.


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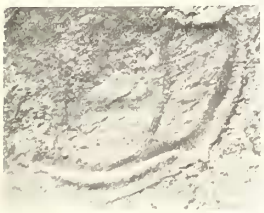
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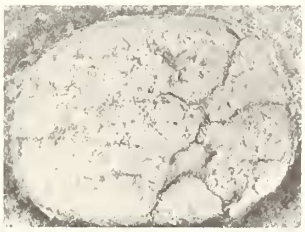
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JAGO, Tasmanian agnostids

Zonate, gently convex pygidium appears to have smooth pleural fields; it is probably slightly wider than long. Wide border with a wide, elevated convex rim which narrows quite considerably to anterior. Wide, moderately deep marginal furrows. Moderately geniculate, strongly elevated shoulders; the fulcra occur mid-way between abaxial acrolobe margin and axial furrows; facets are gently concave. Articulating device consists of a deep, posteriorly arched articulating furrow and a narrow elevated half-ring. Two small border spines present.

Between the spines the convex posterior rim is evenly curved but does not stand out as markedly as do the lateral rims. Narrow, shallow, crescentic furrow between rim and collar. Collar and rim join to form slightly thickened abaxial rim portions. Collar is sometimes slightly depressed at mid-point. On either side of this depression (if present) the collar may be slightly thickened and elevated to form a pair of weak, transversely elongated knobs. The thickening of the collar is present on most specimens, but the central depression in the collar is seen in only about 15% of the specimens. Posterior marginal furrow is curved gently to the posterior at its mid-region where the axis protrudes slightly to the posterior of the pleural areas.

Pygidial axis outlined by moderately wide, deep furrows. It is divided into two parts by what appears in many specimens to be a broad lateral pygidial furrow, which is present just to the posterior of the centre of the axis. This feature does not extend abaxially to the axial furrow and in fact is a pair of clavagnostid pits as described below. Anterior half of axis has almost parallel axial furrows and three annulations, the anterior two of which are outlined by widening of the axis around each annulation. From posterior end of second annulation axis expands evenly until it is widest in region of clavagnostid pits, from which axis contracts to broadly rounded posterior which extends slightly on to posterior marginal furrow.

On the three anterior annulations there is a prominent elongated median ridge just under a third the width of axis; ridge is best developed on the two anterior annulations and is outlined by shallow longitudinal furrows. On the third annulation the ridge is less elevated than it is on the two anterior annulations and extends slightly on to the lateral furrow. The lateral furrow has a raised central region immediately behind the node with small clavagnostid pits on either side.

There are notular lines (not visible on all specimens) on posterior axial lobe. On UT 92480 (Pl. 26, fig. 10), one of the largest available specimens, these notular lines have been accentuated by distortion and occur as distinct furrows. Intranotular axis is set very slightly above extranotular axis.

Discussion. Tasagnostus debori sp. nov. is compared with *T. compani* in the discussion on the latter species. There is some intraspecific variation in *T. debori*, e.g. the pygidial collar on some specimens is wider than on others. As noted in the description, the central collar depression is present in only about 15% of the specimens. The pygidial rear of some specimens is much more broadly rounded than on others even when the effects of distortion are taken into account. The preglabellar median furrow is well developed on some specimens and almost absent on others. In the immature pygidium, UT 86877d (Pl. 26, fig. 8), the clavagnostid pits are placed further to the posterior than in more mature specimens.

Occurrence and age. T. debori sp. nov. occurs in great abundance in the lower fauna

at Christmas Hills and in very small numbers in the upper fauna from Christmas Hills; its age is probably of the *L. laevigata* I or II Zones.

Tasagnostus compani sp. nov.

Plate 25, figs. 10–16

Material. A total of about thirty individual cephala and pygidia are available for description.

Holotype. Pygidium, UT 92724 (Pl. 25, fig. 11).

Diagnosis. Highly convex cephalon; very faint transverse glabellar furrow; moderately sized basal lobes. Zonate pygidium has a pair of transversely elongated knobs on collar. Collar is only a little wider than axial posterior. Third axial annulation has a distinct lateral boss at either extremity; they protrude slightly into the pleural areas. Pleural areas are gently pitted, particularly opposite third axial annulation. Just to posterior of centre of axis is a lateral furrow with a pair of pits on either side of low central rise. This furrow shallows abaxially. Posterior axial lobe is subsquare.

Description. Strongly convex cephalon about as wide as long. Wide, shallow marginal furrow; moderately wide, elevated, convex rim. Glabella outlined by moderately deep axial furrows which shallow forwards; it is divided by a very shallow transverse glabellar furrow which in most specimens is a change of slope rather than a distinct furrow. Very shallow short preglabellar median furrow does not extend to marginal furrow. Glabella has length about two-thirds that of cephalon; it has a broadly rounded anterior. Anterior glabellar lobe has length about one-quarter that of glabella. Narrow, elongated node at anterior end of posterior glabellar lobe. Glabellar rear is angular. Basal lobes do not meet beneath the glabellar rear.

Strongly convex, zonate pygidium about as wide as long. Elevated, gently convex rim moderately wide at posterior, narrows markedly to anterior. Wide, deep marginal furrow. Moderately wide and deep shoulder furrows; slightly geniculate, narrow, elevated shoulders, fulcra placed near centre of shoulders. Agnostoid articulating device includes posteriorly arched articulating furrow; half-ring arched to posterior at its centre. Small border spines. Posterior rim between spines is slightly convex with narrow, shallow furrow between rim and collar. Collar has width only a little greater than that of pygidial rear. Collar has two transversely elongated knobs which are separated by a small central saddle.

Pygidial axis is divided into two parts by a broad transverse furrow which occurs slightly to the posterior of the centre of the axis. This furrow is basically a pair of large pits (clavagnostid pits) separated by a small, central higher area; abaxial ends of furrow are shallow and curve slightly to posterior. Axis outlined by broad, moderately deep axial furrows. Over all the axial furrows are parallel; there is a slight constriction at the second axial lobe, and a slightly expanded posterior axial lobe.

Anterior portion of the axis contains three lobes of approximately equal length. Third lobe has a small lateral boss at either extremity. These bosses protrude slightly into pleural areas; axis is widest at this point. A prominent median ridge, about one-third the width of the axis, extends the length of the three anterior lobes. It is composed of three connected large nodules and is most prominent on the second annulation where it is outlined by prominent longitudinal furrows. Steep drop from the second

lobe nodule down to third lobe nodule. Ridge has a short posterior extension from third lobe on to the wide, deep lateral furrow. This extension is mirrored on the enlarged subsquare posterior pygidial lobe. Posterior lobe has two faint ridges extending longitudinally in the position where notulae would be expected. Between these ridges the intranotular axis stands out very slightly above the extranotular axis; it extends slightly but distinctly further towards the collar than does the extranotular axis. Axis extends slightly further to posterior than do pleural areas. Pleural areas of some specimens are slightly pitted.

Discussion. T. compani sp. nov. differs from *T. debori* sp. nov. in that it has a less distinct transverse glabellar furrow and a less well-developed preglabellar median furrow. The third pygidial lobe has a distinct pair of lateral bosses which is not the case in *T. debori*. The pleural areas of *compani* may be slightly pitted; those of *debori* are smooth. The lateral pygidial furrow housing the clavagnostid pits is bigger in *compani* than *debori*. The collar of *compani* is not as wide (tr.) as that of *debori*, but the knobs are more distinct.

Occurrence and age. T. compani sp. nov. comes from the St. Valentines Peak area; its age is of either the *L. laevigata* III Zone or the *Damesella torosa-Ascionepea janitrix* Zone.

Subfamily Unknown

Genus UTAGNOSTUS Robison, 1964

Utagnostus Robison, 1964, p. 532.

Type species. Utagnostus trispinulus Robison, 1964, p. 533, pl. 82, figs. 21–28.

Diagnosis. See Robison 1964, p. 532.

Discussion. Utagnostus has constricted acrolobes and a simplimarginate, smooth pygidium. These features, plus the presence of only a faint transverse glabellar furrow in *U. trispinulus* and the absence of a transverse glabellar furrow in the new species, *U. neglecta*, could indicate affinities with the subfamily Clavagnostinae (family Clavagnostidae). However, the pygidial axis of *Utagnostus* bears no resemblance to those of the Clavagnostidae. Of the Diplagnostidae only *Oidalagnostus* (Oidalagnostinae) and *O.*? *dubius* (Diplagnostinae) have a trispinose pygidium as has *Utagnostus*. There is a great range of variation within the Diplagnostidae and the Clavagnostidae, and the characters of *Utagnostus* do not allow it to be placed in any particular subfamily. However, I follow Öpik (1967, p. 78) who placed *Utagnostus* in the Diplagnostidae. The new species, described below, *U. neglecta*, from the *L. laevigata* I Zone at Christmas Hills is of very similar age to the type species, *U. trispinulus* from the *Bolaspidella contracta* Subzone of Utah. *Utagnostus*(?) sp. from St. Valentines Peak and an undescribed specimen, a possible *Utagnostus*, from Sugarloaf Gorge in north-western Tasmania (referred to as cf. *Clavagnostus* sp. in Table 2, Jago 1973), are also of late middle Cambrian age. This may indicate that *Utagnostus* is largely confined to late middle Cambrian rocks.

Utagnostus neglectus sp. nov.

Plate 23, fig. 13

Material. One well preserved, complete specimen, UT 86844i, the holotype (Pl. 23, fig. 13).

Diagnosis. Moderately convex small cephalon with long spines. Preglabellar median furrow absent. Anterior one-third of apparently single-lobed glabella is markedly narrower than rest of glabella, probably indicates a bilobed glabella. Simple basal lobes connected behind subangular glabellar rear. Trispinose pygidium with central spine smaller than lateral spines. Pygidial axis extends almost to posterior border furrow. No lateral axial furrows and very little constriction at anterior of axis. Bluntly rounded axial rear.

Description. Moderately convex small cephalon about as wide as long. Narrow shallow marginal furrow; slightly elevated gently convex rim. Long cephalic spines arise from wide bases and extend along thoracic margins to anterior of posterior thoracic segment. Preglabellar median furrow absent. Smooth cheeks. Glabella outlined by moderately wide and deep axial furrows; it has a bluntly rounded front. Length of glabella about 0·7 that of cephalon. Small, simple basal lobes connect behind subangular glabellar rear. Anterior one-third of the apparently single-lobed glabella is markedly narrower than posterior part of glabella. This marked change in width probably represents the trace of a bilobed glabella. At the centre of the posterior glabellar lobe is a broad rounded high area rather than a distinct node.

Small pygidium about as wide as long. Narrow, shallow marginal furrow; slightly elevated, gently convex rim is moderately wide between the moderately long lateral border spines but narrows anteriorly. There is a short median marginal spine. Narrow, shallow shoulder furrows, abaxially placed fulcra; articulating device unknown. Pygidial axis extends almost to marginal furrow. Axis outlined by narrow, shallow furrows. No lateral furrows. Axis is very slightly constricted at position of a second axial lobe. Axial rear bluntly pointed. Broad rounded area at position of second axial lobe rather than a distinct node.

Discussion. The cephalon of *Utagnostus neglectus* differs from that of *U. trispinulus* in that *trispinulus* has a more clearly defined transverse glabellar furrow. The three pygidial spines of *trispinulus* are of approximately equal size, but the central spines of *neglectus* appears to be smaller than the lateral spines. However, it should be noted that the central spine of *neglectus* is not very well preserved. The pygidial axis of *trispinulus* differs from that of *neglectus* in that it extends further to the posterior and it widens more at the posterior and has a more marked anterior constriction. The rim of the pygidium of *trispinulus* is wider than that of *neglectus*.

Occurrence and age. U. neglectus sp. nov. comes from the lower fauna at Christmas Hills; its age is probably *L. laevigata* I Zone.

Utagnostus(?) sp.

Plate 23, figs. 14–17

Material. Two partially complete specimens, one individual cephalon and an individual pygidium. All are reasonably well preserved.

Description. Strongly convex cephalon about as wide as long. Narrow, shallow marginal furrow; slightly elevated, narrow convex rim. Long cephalic spines arise from wide bases; spines extend along lateral thoracic margins almost to anterior margin of pygidium. No preglabellar median furrow (the apparent furrows in UT 92698 (Pl. 23, fig. 15) and UT 92699 (Pl. 23, fig. 17) are distortion features). Smooth cheeks. Glabella outlined by wide, deep subparallel axial furrows; it has a bluntly rounded front. Length of glabella about two-thirds that of cephalon. Small, simple basal lobes connected behind glabellar rear. Posterior part of glabella is very high and is greatly elevated above the cheeks and also the flat anterior third of the glabella which is below the level of the surrounding cheeks. The marked change in elevation from the low anterior third of the glabella to the high posterior portion may represent the vestige of a bilobed glabella. Glabellar rear not seen clearly in any available specimen.

Pygidium about as wide as long; it is not as strongly convex as the cephalon. Narrow, shallow marginal furrow; slightly elevated, gently convex rim is moderately wide between the long border spines but narrows anteriorly. Small median salient in pygidial border. Narrow, shallow shoulder furrows; narrow convex shoulders; the fulcra are not visible. Articulating device is unknown.

Strongly convex pygidial axis stands out strongly above smooth pleural fields which are separated behind the axis by a short, narrow, shallow post-axial furrow. Axis lacks lateral furrows; it is somewhat constricted at the position of a second axial lobe. Axial rear bluntly pointed. Axis has length about 0·7 that of pygidium. Low, elongated node on anterior half of axis.

Discussion. Apart from the lack of a third pygidial spine, the species described above fits into *Utagnostus*. It is referred to *Utagnostus*(?) sp. and is the species referred to as cf. *Clavagnostus* sp. in Jago (1973, p. 411).

Occurrence and age. Utagnostus(?) sp. comes from the St. Valentines Peak area; its age is either *L. laevigata* III Zone or the *Damesella torosa-Ascionepea janitrix* Zone.

Family and Subfamily unknown

Agnostid, gen. et sp. indet. no. 1

Plate 26, fig. 15

Material. Two incomplete pygidia.

Remarks. These pygidia appear to be of a similar type to those described by Rasetti 1967, p. 38, as Agnostida, pygidium, no. 1. The Tasmanian specimens do not show the articulating device, and the shoulder area is seen only in the smaller specimen. These specimens do not permit anything to be added to or any comments to be made on the discussion given by Rasetti (1967). Rasetti's specimens are associated with *Centropleura* and are hence of a similar but slightly older age to the two pygidia from St. Valentines Peak. These pygidia are referred to here as Agnostid, gen. et sp. indet. no. 1.

Occurrence and age. Agnostid, gen. et sp. indet. no. 1 comes from the St. Valentines Peak area; its age is either late middle Cambrian, the *L. laevigata* III Zone, or the *D. torosa-A. janitrix* Zone.

Agnostid, gen. et sp. indet. no. 2

Plate 26, fig. 14

Material. Two pygidia, UT 92690 and UT 92691. UT 92691 is well preserved, and the following description is based almost entirely on that specimen.

Description. Pygidium about as wide as long. It has a convex anterior end and a flat posterior. Acrolobes are unconstricted; wide border with a wide convex elevated rim which becomes less convex and quite narrow to the anterior. Rim has a low posterior median salient. Wide, moderately deep marginal furrow. Shoulder areas are poorly preserved, but the shoulder furrows are narrow and shallow; the shoulders appear to be low and convex with no geniculation. The fulcra seem to be very close to the axis, which is outlined by wide, moderately deep, axial furrows. Axis is wide at anterior; it tapers fairly evenly to the posterior with a slight constriction about one-third of the distance to the sharply rounded posterior. Immediately to the posterior of the axis is a large depression caused by the meeting of the axial furrows and the posterior marginal furrow. Border spines absent; smooth pleural fields. Small axial node placed just to the anterior of the axial constriction. No details of the articulating device are visible.

Discussion. As far as I can determine, these pygidia have no affiliation with any known agnostid genus or species. They are referred to as Agnostid, gen. et sp. indet. no. 2.

Occurrence and age. This species comes from the St. Valentines Peak area; its age is either the *L. laevigata* III Zone or the *D. torosa-A. janitrix* Zone.

Agnostid, gen. et sp. indet. no. 3

Plate 26, figs. 16–19

Material. Numerous poorly preserved cephala and pygidia. Two poorly preserved complete specimens are known including UT 88620 (Pl. 26, fig. 16).

Description. Moderately convex cephalon probably about as wide as long. When undistorted, it would have had a subcircular outline with a straight posterior margin; cephalon is widest near the posterior end about one-quarter of the distance to the broadly rounded anterior margin. Narrow border rarely visible due to overhanging acrolobe margins. Apart from faint traces of a slightly elevated rounded glabellar rear, the cephalon is smooth.

Pygidium probably slightly longer than is wide. Wide, gently convex, elevated rim, narrows considerably forwards; narrow, shallow marginal furrow. The shoulder and marginal furrows meet at an angle of just over 90°. Narrow, elevated shoulders. Articulating device consists of a moderately convex articulating half-ring which is arched gently forward and a moderately deep articulating furrow which is also arched forward. The only dorsal features on the acrolobe are shallow axial furrows at the anterior end of the pygidium where the axis has a width about two-fifths that of the pygidium.

Discussion. This effaced agnostid cannot be placed with certainty into any genus as all specimens have been considerably crushed and distorted. The pygidial border is

wide, thus excluding *Lejopyge*; it may be a species of either *Grandagnostus* or *Pseudophalacroma*. The high degree of effacement and poor preservation makes detailed classification out of the question. This species is referred to as Agnostid, gen. et sp. indet. no. 3.

Occurrence and age. This species comes from the upper fauna at Christmas Hills; its age is either the *L. laevigata* I Zone or the *L. laevigata* II Zone.

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